FLIGHT SAFETY FOUNDATION
Accident Prevention
Vol. 57 No. 7 *For Everyone Concerned With the Safety of Flight* July 2000

Pilot Loses Control of Twin Turboprop During ILS Approach in Low Visibility

The accident report said that the corporate pilot selected an incorrect source of distance-measuring equipment information and did not fly the proper descent profile for the instrument landing system approach. Airspeed decreased rapidly during the final segment of the approach before the Beech Super King Air 200 stalled and struck the ground.

FSF Editorial Staff

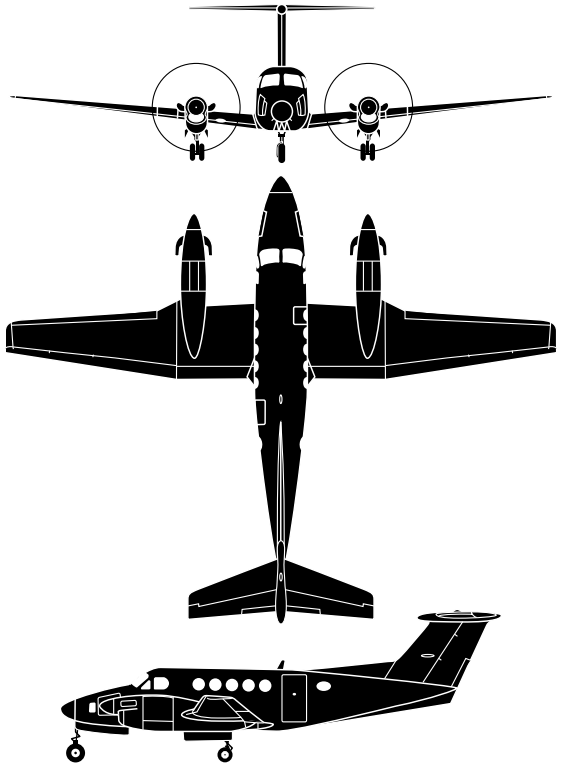
At 1913 local time March 2, 1997, a Beech Super King Air 200 stalled and struck the ground approximately 1.3 nautical miles (2.4 kilometers) from the runway during an instrument landing system (ILS) approach to Salt Lake City (Utah, U.S.) International Airport. The accident occurred at night in instrument meteorological conditions that included low visibility and snow showers. The pilot and two passengers were seriously injured; one passenger was killed. The aircraft was destroyed.

The U.S. National Transportation Safety Board said, in its final report, that the probable cause of the accident was "the pilot's failure to maintain adequate airspeed on the ILS approach, resulting in a stall. Factors included: low visibility, the pilot's selection of the improper DME [distance-measuring equipment] for the approach; his resulting failure to attain the proper descent profile for the approach; and insufficient altitude available for stall recovery."

The business flight to Salt Lake City from Las Vegas, Nevada, was conducted under the general operating requirements of U.S. Federal Aviation Regulations Part 91. [Salt Lake City is approximately 312 nautical miles (578 kilometers) north-northeast of Las Vegas.]

The pilot was chief pilot for El Cortez Hotel and flew part-time for Coast Hotels & Casinos, which owned the accident aircraft. Both companies were based in Las Vegas.

The pilot, 55, held an airline transport pilot certificate and type ratings in the Beech 400, Cessna 500 and Mitsubishi 300. He had 8,172 flight hours, including 1,841 flight hours in the Beech 200. He received initial training in the Beech 200 in 1986 and recurrent training in type in 1987; the training was conducted by FlightSafety International in Long Beach, California.



Beech Super King Air 200

Design of the Beech Super King Air 200 business and utility twin-turboprop aircraft began in 1970. The first prototype flew in 1972. The aircraft has the same basic fuselage as the King Air 100 and has increased wingspan, more powerful engines, increased fuel capacity, increased cabin pressurization and a higher gross weight.

The aircraft is certified for single-pilot flight under U.S. Federal Aviation Regulations Part 91. The cockpit has two seats, and the cabin has six seats. Maximum cabin pressure differential is 6.5 pounds per square inch (0.4 bar). The cabin door is in the aft, left side of the fuselage. The aft fuselage accommodates a lavatory and a baggage compartment of 410 pounds (186 kilograms) capacity.

Each of the two Pratt & Whitney PT6A-41 engines produces 850 shaft horsepower (634 kilowatts) and drives a Hartzell three-blade, metal propeller. Maximum fuel capacity is 3,645 pounds (1,653 kilograms).

Maximum takeoff and landing weight is 12,500 pounds (5,670 kilograms). Maximum cruise speed at 25,000 feet and average cruise weight is 289 knots (536 kilometers per hour [kph]). Maximum rate of climb at sea level is 2,450 feet per minute. Maximum single-engine rate of climb at sea level is 740 feet per minute. Stall speed with flaps up is 99 knots (183 kph). Stall speed with flaps fully extended is 76 knots (140 kph).

Source: *Jane's All the World's Aircraft*

"The pilot stated that he had not received any formal training [in] the Beech 200 since the 1987 recurrent training," the report said. "He reported that his most recent pilot-proficiency check was a pilot-proficiency evaluation conducted in a Beech 400 jet aircraft simulator on April 6, 1996."

The pilot said that in the six months preceding the accident, he accumulated 39.8 flight hours, including approximately 13 flight hours on instruments, in the Beech 200.

"Logbook information supplied by the pilot indicated that he was current for night, instrument and multi-engine flight at the time of the accident but had not flown into or out of Salt Lake City within the past six months," said the report.

The aircraft, N117WM, was built in 1980 and later was modified according to supplemental type certificates held by Raisbeck Engineering. The modifications included installation of Hartzell four-blade propellers, ram-air recovery systems in the engine air intakes, redesigned wing leading edges, doors that fully enclose the main landing gear and ventral strakes on the aft fuselage.

At the time of the accident, the airframe had accumulated 4,618 hours and the engines had accumulated 4,790 hours, including 1,765 hours since overhaul. The aircraft had been flown 172 hours after the airframe and engines were inspected on May 23, 1996.

"According to the aircraft maintenance records, the airplane was on a manufacturer-approved airworthiness-inspection program," the report said. "No discrepancies were noted in the aircraft maintenance records regarding required inspections, to include the altimeter and static system tests required for IFR [instrument flight rules] operations."

The aircraft was not equipped (and was not required to be equipped) with a cockpit voice recorder or a flight data recorder.

The report said that, on the morning of the accident, the pilot arose at 1000 after 10 hours of uninterrupted sleep. He ate breakfast at 1100 and drank coffee just before the flight began.

The pilot obtained a weather briefing before departure from Reno (Nevada) Flight Service Station and filed an IFR flight plan. He also discussed weather conditions with a pilot who had flown to Las Vegas from Salt Lake City.

At the time, a cold front was moving toward Salt Lake City from the northwest. The terminal forecast for Salt Lake City after 1800 called for surface winds from 300 degrees at 18 knots, gusting to 28 knots, visibility greater than six statute miles (9.7 kilometers), scattered clouds at 1,000 feet and a broken ceiling at 4,000 feet. The forecast also said that from 1800 to 2000, weather conditions temporarily could include one-half mile (0.8 kilometer) visibility, moderate snow showers, an indefinite ceiling and 800 feet vertical visibility.

Airmets (in-flight advisories) were in effect for occasional moderate turbulence below 18,000 feet and occasional moderate rime ice and/or mixed ice in clouds and precipitation between the freezing level and 18,000 feet.

The aircraft departed at 1700 from Las Vegas with 2,400 pounds (1,089 kilograms) of fuel. The pilot said that the flight proceeded uneventfully and in visual meteorological conditions until the final segment of the ILS approach to Salt Lake City.

The aircraft was at 15,000 feet at 1859 when the flight was handed off to Salt Lake City Terminal Radar Approach Control (Salt Lake Approach). The approach controller told the pilot that the aircraft was 26 nautical miles (48 kilometers) from the PLAGE intersection, to turn to a heading of 010 degrees and to cross PLAGE at or above 11,000 feet. The controller then cleared the pilot to conduct the ILS approach to Runway 34R [see Figure 1, page 4].

At 1900, the controller told the pilot that the runway-visual-range equipment was out of service and that visibility was one-half mile. The report said that snow was falling at moderate intensity in the area.

Recorded air traffic control (ATC) radar data show that, at 1901, the pilot began a descent from 15,000 feet. The aircraft was 18 nautical miles (33 kilometers) south of PLAGE at the time.

The controller told the pilot to report his airspeed. The pilot said that his indicated airspeed was 180 knots. The controller said, "Maintain best forward speed."

The pilot acknowledged the instruction and then began a left turn to intercept the localizer course.

ATC had sequenced the King Air behind a Boeing 757, which also was being flown on the ILS approach.

At 1904, the controller said, "King Air seven whiskey mike, maintain best forward speed until, ah, SCOER, cross KERNN at one seven zero knots, contact tower now [on frequency] one one niner point five."

The pilot acknowledged the approach controller's instructions. The pilot said during a postaccident interview by investigators that the instruction to cross KERNN at 170 knots was "not unmanageable."

"He stated that he would normally want to be at 140 knots at that point, which is the prescribed speed for the airplane for icing conditions," said the report.

The pilot changed radio frequencies and told the tower controller, "Salt Lake City Tower, King Air one one seven whiskey mike with you at twelve five [12,500 feet] for one one thousand."

The controller told the pilot to continue the ILS approach.

Figure 1 shows that at the time of the accident, DME or ATC radar service was required to conduct the ILS Runway 34R approach. The PLAGE, SCOER and KERNN intersections were defined by distances from a DME ground station located 0.1 nautical mile (0.2 kilometer) south of the Runway 34R threshold. The DME frequency was paired with the localizer frequency.

The report said that the ILS/DME was commissioned on Sept. 11, 1996.

"Prior to the commissioning of the ILS/DME, fixes on the ILS Runway 34R approach were defined using DME from the Salt Lake City VORTAC," the report said. "The [U.S. Federal Aviation Administration (FAA)] reported that the change to the ILS approach procedure, in which the approach fixes were defined by the ILS/DME, rather than by the Salt Lake City VORTAC, was published on Aug. 7, 1996, with an effective date of Sept. 12, 1996."

Investigators found a current ILS Runway 34R approach chart among the wreckage but also found that the switch on the aircraft's flight director system that controls the DME display on the pilot's horizontal situation indicator (HSI) was set to a navigation receiver tuned to the Salt Lake City VORTAC frequency. The VORTAC is 4.7 nautical miles (8.7 kilometers) north-northwest of the ILS/DME ground station.

Recorded radar data showed that, at 1906:32, the aircraft flew over PLAGE at 11,800 feet — 1,300 feet above the published minimum altitude at PLAGE and 800 feet above the altitude that had been assigned by the approach controller. The aircraft was at 10,600 feet — 100 feet above the published minimum altitude for PLAGE — when it was 4.7 nautical miles northwest of PLAGE.

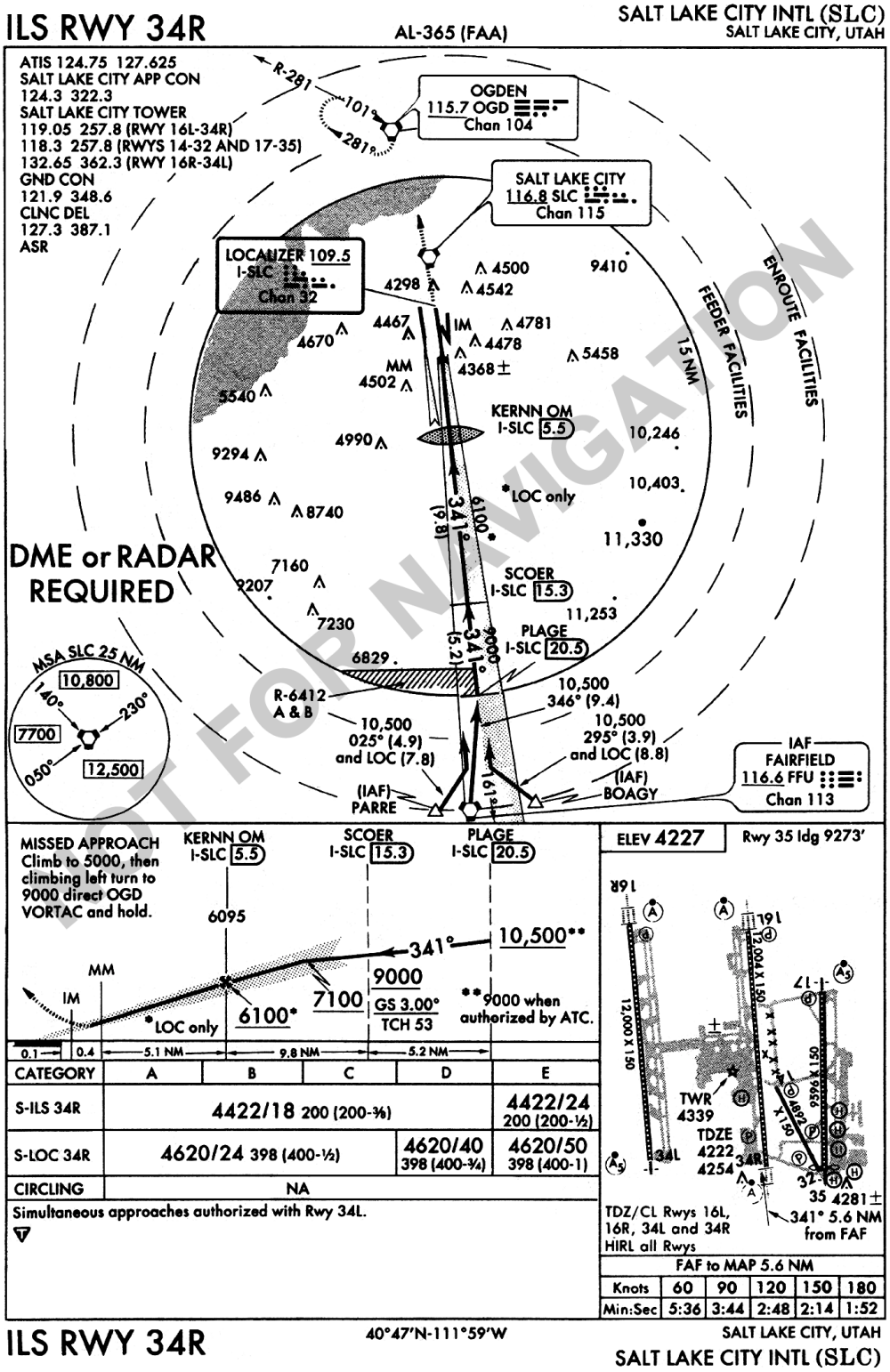
The data showed that, at 1907:55, the aircraft flew over SCOER at 10,500 feet — 1,500 feet above the published minimum altitude at SCOER without ATC authorization of a lower altitude. The aircraft was between 8,900 feet and 9,000 feet (the published minimum altitude for SCOER) when it was 4.7 nautical miles northwest of SCOER.

ATC had sequenced the King Air behind a Boeing 757, which also was being flown on the ILS approach.

At 1910, the controller said, "King Air one one seven whiskey mike, caution wake turbulence, Boeing seven fifty-seven, six miles ahead; wind three six zero at one five, runway three four right, cleared to land."

The pilot acknowledged the controller's transmission. About 25 seconds later, the aircraft crossed KERNN, the outer marker, at 7,000 feet. The aircraft's groundspeed at this time was 163 knots.

Instrument Landing System Runway 34R Approach, Salt Lake City (Utah, U.S.) International Airport, March 2, 1997



CATEGORY	A	B	C	D	E
S-ILS 34R	4422/18 200 (200-⅜)				4422/24 200 (200-½)
S-LOC 34R	4620/24 398 (400-½)			4620/40 398 (400-¾)	4620/50 398 (400-1)
CIRCLING	NA				

Simultaneous approaches authorized with Rwy 34L.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service

Figure 1

At 1911, the controller told the pilot that an Embraer Brasilia was holding in position for takeoff on Runway 34R. The pilot's acknowledgement of the controller's advisory was the last recorded radio transmission from the aircraft.

The pilot recalled that he increased the aircraft's rate of descent so that the autopilot would capture the glideslope.

"[The pilot] did not recall his airspeed when he increased the rate of descent to capture the glideslope," the report said. "He stated that the autopilot-capture light illuminated when the glideslope was captured. He stated that after glideslope capture, pitch control was assumed by the autopilot to maintain glideslope, but he did not recall adjusting the power."

The report said, "ATC radar data indicated that the aircraft remained above the glideslope from KERNN until attaining the glideslope from above about 1.8 nautical miles [3.3 kilometers] from the [runway] threshold."

The aircraft's groundspeed was 103 knots when it intercepted the glideslope at 4,900 feet (478 feet above decision height [DH]).

The pilot said, "At this time, the aircraft was entering the cloud deck. All anti-icing and deicing systems were verified on, approach flaps were lowered, and the [landing] gear was extended. Power was adjusted to approximately 600 foot-pounds torque per engine in order to maintain 140 knots IAS [indicated airspeed]. From this point until the last few seconds of the flight, I have no memory recall."

The report said that the aircraft remained on the glideslope for 28 seconds. During this time, the aircraft's groundspeed decreased to 73 knots.

The report said that the aircraft remained on the glideslope for 28 seconds. During this time, the aircraft's groundspeed decreased to 73 knots.

"During the 28-second period the aircraft was on the glideslope, its average rate of radar groundspeed decay increased from 0.54 knots per second (between KERNN and the time of glideslope capture) to 1.07 knots per second," said the report.

Recorded radar data showed that the aircraft then descended 200 feet in four seconds. The lowest groundspeed recorded during this time was 70 knots.

"The loss of 200 feet of altitude (from 4,700 to 4,500 feet) from 1913:10 to 1913:14, in combination with the radar groundspeed of 70 knots during this interval, was computed to correspond to an average downward vertical flight path angle during the interval of 20.3 degrees below the horizontal," said the report.

At 1913:18, radar contact with the aircraft terminated.

"The last radar return recorded [showed the aircraft] at 4,400 feet altitude (approximately 200 feet above the touchdown zone elevation) and 71 knots," said the report.

The pilot recalled that the aircraft was 400 feet above the ground, as indicated by the radar altimeter, when an upset occurred. He did not recall the airspeed indication when the upset began.

"The aircraft did a sudden, uncommanded, skidding yaw to the left, with a following nose-down, wing-down roll to the left," the pilot said. "My instinctive reaction was full-right aileron, full-right rudder, full power and nose-up pitch. At this time, I had visual [contact] outside the aircraft. The control input slowed the rate of roll, and the aircraft started to return to level flight.

"As I began to relax the control inputs, the rolling motion returned. At this time, I could see a large, white space in front of me, and I could visually see that the aircraft was descending. I had full control input in, attempting to level the aircraft prior to impact. I do not recall the impact."

The report said that the two surviving passengers recalled that the approach initially seemed normal and that they could see objects on the ground.

"They reported that at some point after the point [at] which ground objects became visible (none were visible directly out the front of the windscreen, according to the copilot's seat passenger), the aircraft suddenly rolled left and struck the ground," the report said. "One passenger, who was sitting in the back of the aircraft (on the right side, across the aisle from the fatally injured passenger) at the time of the accident, reported that the aircraft rolled left, straightened out, then rolled left again (more severely) and struck the ground.

"The other passenger, who was sitting in the copilot's seat at the time, reported that the airplane rolled left and struck the ground approximately two [seconds] to three seconds after the left roll, and that the aircraft rolled left despite the pilot moving the control yoke noticeably to the right.

"Both passengers reported briefly hearing what they thought was a warning horn of some type during the event but could not recall noting any significant changes in the engine noise during the accident sequence."

The report said, "[The pilot] did not recall any warning or caution lights illuminating, nor any audible alarms sounding before or at the time of the occurrence."

The aircraft struck the ground about 0.25 nautical mile (0.5 kilometer) west of the extended runway centerline. The impact occurred in a level pasture. There was no fire.

"All aircraft components were located at the crash site," the report said. "The majority of the aircraft wreckage was contained along a line approximately 225 feet [69 meters] long and oriented 290 degrees magnetic from the first point of ground damage observed to the main aircraft wreckage."

The report said that the fuselage nose section and cabin section were "largely intact."

"Investigators were able to enter the cabin through the primary entry door and negotiate a path to the pilot's and copilot's seats, although the cabin headliner had collapsed and seats and interior cabin furnishings were damaged and/or separated from their mountings," the report said. "A variety of debris was scattered throughout the cabin interior. The net for the cargo compartment was found unsecured."

The report said that the aircraft had 360 pounds (163 kilograms) of cargo.

"Cargo carried in the aft cargo compartment included pots and pans, dishes, various types of food and beverages; some of this cargo was found scattered in the cabin and outside the aircraft, which was broken to the left immediately aft of the aft pressure bulkhead but otherwise largely intact."

The passenger killed in the accident was seated in the left, rear seat. An autopsy was conducted by the Utah State Medical Examiner's Office in Salt Lake City.

"The immediate cause of death was given as blunt-force injuries to the head," the report said. "The [medical examiner's] report stated the examiner's opinion that 'she was apparently struck from behind by an object causing an acute hyperflexion of the head forward.'"

The report said that none of the objects recovered at the accident site showed evidence of having struck the passenger.

"In [a postaccident] interview with the pilot, the pilot stated that he personally secured the cargo-compartment net before takeoff," said the report.

The passenger in the copilot's seat was wearing a seat belt and shoulder harness; he suffered a broken neck, broken back, lacerated left elbow, bruised right arm and lacerated scalp. The passenger in the right rear seat was wearing a seat belt, but he was not wearing a shoulder harness; he suffered a fractured right knee, cracked lower-back vertebrae, chest bruises, left-ankle pain, lower-back pain and a cut on his scalp. The pilot suffered lacerations and a broken leg.

"Following the accident, the pilot was taken to [a hospital] for emergency medical treatment," the report said. "A consent to release of records was obtained from the pilot. … The pilot's treatment records indicated that, at the time of admission, a drug-and-alcohol screen was performed on the pilot. The pilot tested negative for all drugs screened and also tested at less than 0.01 percent serum ethyl alcohol volume."

The report said that the aircraft's stall-warning switch and the two pitot-heat switches were in the "off" position.

"The stall-warning [switch] and the pitot-heat switches were located on the lower right side of the pilot's instrument panel, immediately above the pilot's right leg, which was trapped in the wreckage after the accident and required extrication by rescue personnel in order to free the pilot from the wreckage," said the report.

The report said, "[The pilot] stated that he turned on the pitot heat before takeoff and that the pitot heat is normally operated full-time during flight."

An FAA inspector who examined the aircraft after the accident said that he saw no evidence of ice on the aircraft.

An FAA inspector who examined the aircraft after the accident said that he saw no evidence of ice on the aircraft.

"The Salt Lake City FAA air traffic manager reported that there were no pilot reports of wind shear or icing conditions to ATC during the time frame of the accident," the report said. "There were also no wind shear alerts recorded by the airport's low-level wind shear alerting system (LLWAS)."

The report said, "The pilot of the accident aircraft reported … that his ride down final was smooth and that the aircraft did not accumulate any ice on the windshield or wings during the approach."

The pilot's HSI, attitude director indicator and altimeter, and the aircraft's air-data computer, flight-director computer, automatic flight control computer and autopilot servos were tested by the manufacturer under the supervision of an FAA manufacturing inspector.

"Although isolated test failures were recorded on each of these components, the FAA manufacturing inspector who supervised the tests on these components reported: 'The general feeling of the test personnel and me is that the instruments with the noted discrepancies would not have placed the aircraft in jeopardy, would have caused conditions that the pilot would be aware of, or may have been caused by the impact,'" said the report.

The aircraft's navigation receiver was tested by the manufacturer under the supervision of an FAA inspector.

The report said, "The FAA inspector supervising this test reported: 'Receiver sensitivity was weak at some parameters,

but overall indications were positive. The sensitivity issue was not deemed unusual or overtly significant by the engineers conducting the testing or [by] the bench technician. No other unusual circumstances were observed.'"

No discrepancies were found during testing of the aircraft's pitot-probe heaters and airspeed indicators.

The report said that the aircraft was within weight-and-balance limits and had approximately 1,417 pounds of fuel when the accident occurred. Gross weight upon impact was approximately 10,811 pounds (4,904 kilograms).

"According to the FAA-approved Raisbeck supplemental pilot's operating handbook (POH) for the aircraft, a Raisbeck-modified Beech 200 at [a] gross weight of 11,000 pounds [4,990 kilograms] and [with] flaps extended 40 percent (the approach-flap setting) has a stall speed of 81 knots calibrated airspeed (KCAS)," the report said. "At a density altitude of 3,700 feet (the computed Salt Lake [City] density altitude at the time of the accident, based on reported temperature [1 degree Celsius (34 degrees Fahrenheit)] and altimeter setting [29.80]), 81 KCAS was computed to correspond to a true airspeed of 86 knots.

"Based on the radar groundspeed of the aircraft from the 1913:10 and 1913:14 radar returns (73 [knots] and 70 knots, respectively) and the wind reported by Salt Lake Tower to N117WM at the time of landing clearance (360 degrees at 15 knots), N117WM's true airspeed at 1913:10 (immediately before it was recorded well below glideslope) was computed to be 88 knots, dropping to 85 knots at 1913:14 (at which time it was recorded well below glideslope)."

The report said that the Raisbeck supplemental POH said that 800 feet of altitude might be lost during recovery from a wings-level stall.

"At 1913:10, the aircraft's altitude (as recorded by radar) was 4,700 feet, or 478 feet above the TDZE [touchdown zone elevation] of 4,222 feet," said the report.

During the postaccident interview, the pilot said that he believed the accident was caused by an encounter with wake turbulence.

"Based on his reflections since the accident, he believed the accident was attributable to wake turbulence from the B-757 he was following," the report said. "When asked if, upon reflection, he thought he could have done anything differently which would have prevented the accident, [the pilot] replied 'not go.' [He] reiterated his belief that the accident was attributable to a wake-turbulence encounter, stating that at the time of the second roll-off, he heard what he described as a 'whoosh, whoosh, whoosh,' or a pulsing wind sound."

The report said that the B-757 did not deviate more than 93 feet above the glideslope during its final approach.

"[The B-757] was computed to be 52 feet above glideslope at 1.8 nautical miles from the threshold, and its average glideslope deviation for its last 11 radar returns (corresponding to 1.8 nautical miles from the threshold down to DH) was computed to be approximately four feet low," the report said. "The ATC radar data indicated that [the B-757] passed 1.8 nautical miles from the threshold at 1910:09, approximately two minutes and 33 seconds ahead of N117WM."

The report said that when the B-757 was over the runway threshold, the King Air was approximately 5.4 nautical miles (10 kilometers) behind the B-757.

"ATC minimum radar separation distance for landing, for a small aircraft following a B-757, is five miles [9.3 kilometers]," said the report.♦

[Editorial note: This article, except where specifically noted, was based on the U.S. National Transportation Safety Board factual report and brief-of-accident report SEA97FA067. The reports comprise 284 pages and include diagrams and photographs.]

Further Reading From FSF Publications

Wilson, Dale R. "Darkness Increases Risks of Flight." *Human Factors & Aviation Medicine* Volume 46 (November–December 1999): 1–8.

"Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and Controlled-flight-into-terrain Accidents." *Flight Safety Digest* Volumes 17 and 18 (November–December 1998, January–February 1999): 1–248.

FSF Editorial Staff. "After Intentionally Stalling DC-8, Crew Uses Incorrect Recovery Technique, Resulting in Uncontrolled Descent and Collision with Terrain." *Accident Prevention* Volume 54 (September 1997): 1–11.

Enders, John H.; Dodd, Robert; Tarrel, Rick; Khatwa, Ratan; Roelen, Alfred L.C.; Karwal, Arun K. "Airport Safety: A Study of Accidents and Available Approach-and-landing Aids." *Flight Safety Digest* Volume 15 (March 1996): 1–36.

FSF Editorial Staff. "Stall and Improper Recovery During ILS Approach Result in Commuter Airplane's Uncontrolled Collision with Terrain." *Accident Prevention* Volume 52 (January 1995): 1–11.

Lawton, Russell. "Steep Turn by Captain During Approach Results in Stall and Crash of DC-8 Freighter." *Accident Prevention* Volume 51 (October 1994): 1–8.

Roed, Aage. "Stall Considerations for Transport Aircraft." *Accident Prevention* Volume 48 (September 1991): 1–4.

Accident Prevention

Staff: Roger Rozelle, director of publications; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; Linda Werfelman, senior editor; Karen K. Ehrlich, production coordinator; Ann L. Mullikin, production designer; Susan D. Reed, production specialist; and Patricia Setze, librarian, Jerry Lederer Aviation Safety Library.

Subscriptions: One year subscription for twelve issues includes postage and handling: US$240. Include old and new addresses when requesting address change. • Attention: Ahlam Wahdan, membership services coordinator, Flight Safety Foundation, Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S. • Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708